

On the type species of *Lingularia*, and description of *Eolingularia* n. gen.

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Abstract: The material under study has previously been identified as *Lingula krausei*, collected from glacial erratics at Cape Rozewie, Poland. All specimens come from glauconitic sandstone of Cenomanian age. DAMES (1874) identified his *Lingula* sp. as *L. krausei* which differs in shell outline from *Lingula truncata*. This species, dedicated to A. KRAUSE, together with *L. subovalis*, is considered characteristic of the Cenomanian. Several new species and genera have recently been described or redescribed and compared to our specimens, here identified as *Lingularia similis*. By priority (ICZN, 1999), the type species *L. similis* is currently synonymized with *Lingula krausei*. A new genus *Eolingularia*, within the Family Lingulidae, is here described, with *Lingularia siberica* BERNAT et EMIG, 1993, as type species. This new genus ranges from the Carboniferous to the Triassic in Russia, China, and Spain. Possible synonymies are discussed.

Key-words:

- Brachiopoda;
- Lingulidae;
- Mesozoic;
- Cenomanian;
- new genus.

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Résumé : Au sujet de l'espèce type de *Lingularia*, et description de *Eolingularia* n. gen.- Le matériel étudié a été précédemment identifié sous *Lingula krausei*, récolté dans des blocs erratiques du cap Rozewie (Poméranie, Pologne). Tous les échantillons proviennent des grès glauconieux d'âge céno-manien. DAMES (1874) décrit sa *Lingula* sp. sous *L. krausei* qui, selon lui, diffère par le contour de la coquille de *Lingula truncata*. Cette espèce, dédiée à A. KRAUSE, est considérée comme caractéristique du Cénomanien, de même que *L. subovalis*. Plusieurs espèces nouvelles et de nouveaux genres ont été décrits récemment ou redécrits et comparés à nos spécimens qui ont été finalement décrits et identifiés comme appartenant à *Lingularia similis*. Selon l'ICZN (1999), l'espèce type *L. similis* est actuellement synonyme de *Lingula krausei*. Au sein de la famille Lingulidae, un nouveau genre a été décrit sous *Eolingularia* avec *Lingularia siberica* BERNAT et EMIG, 1993 ; l'extension géologique va du Carbonifère au Trias, en Russie, Chine, Espagne. De possibles synonymies sont discutées.

Mots-clefs :

- Brachiopoda ;
- Lingulidae ;
- Mésozoïque ;
- Cénomanien ;
- nouveau genre.

Introduction

Lingulides, because of their very low taphonomic potential, are rare fossils and only catastrophic events allow their preservation in the fossil record. Moreover, as external shell characters have no taxonomic value, the identification of lingulides requires examination of soft body parts or their scars in fossil forms, i.e., the muscle scar pattern and the disposition of the main mantle canals (BIERNAT & EMIG, 1993; EMIG, 2003).

The first record of *Lingula krausei* is in DAMES (1873) as *Lingula* sp. from near Bydgoszcz, Poland (in German: Bromberg) (Fig. 1). The outcrop of diluvial Quaternary sand with Upper

Cretaceous (Cenomanian) glacial erratics is located in Fordon, now a district in Bydgoszcz, near of the confluence of the Brda (in German: Brahe) River and the Vistula (in German: Weichsel) River. The valve fragments occur at two levels. DAMES (1873) noted the species' similarities with *Lingula rauliniana* ORBIGNY and *L. truncata* SOWERBY. The former species was synonymised with the latter by DAVIDSON (1852), who described another Cretaceous species, *Lingula subovalis*, distinct from *L. truncata* and *L. ovalis* DAVIDSON "by its more regularly oval shape, and much smaller size": from Fig. 29a, a dorsal valve, of DAVIDSON (1852): H/L = 0,57 and Lc = 35% (Tables 1-2).

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◀ **Figure 1:** Distribution of "*Lingula*" *krausei* from data of DAMES (1873, 1874), KIESOW (1880, 1881), NÖTLING (1885), LEONOV (1974), KHARITONOV *et al.* (2003), SALTYSKOV & PERVUSHOV (2007).

DAMES (1874) assigned his *Lingula* sp. to *Lingula krausei* which differs in its shell outline from *Lingula truncata*. This new species, dedicated to A. KRAUSE, and *L. subovalis* are considered characteristic of the Cenomanian. According to NÖTLING (1881) *L. krausei* occurs in middle and upper Cenomanian erratics found in the valley of the Vistula River and in the lower part of the Nemunas River (formerly Memel), located on the northern border of the Russian enclave of Kaliningrad.

KIESOW (1880, 1881) pointed out that *L. krausei* had been recorded in abundance in the vicinity of Gdańsk (formerly Danzig), where the rocks are in places composed solely of lingulides, in particular in Łęgowo (in German: Langenau or Lang Heinersdorf).

NÖTLING (1885) stated that "wenn auch die Lage der Muskelsmale im Grossen und Ganzen dieselbe ist, wie bei der lebenden *Lingula anatina*, so ergeben sich doch bei genauerer Betrachtung kleine Abweichungen, die eine Besprechung verdienen." His figures (NÖTLING, 1885: Pl. XXVI) of a ventral and dorsal valve of

Lingula krausei are corroborated by our figures (Figs. 2-3).

According to NÖTLING (1885), the number of valves and fragments may be very important in the "*Lingula*-Sandstein". This may be the consequence of the extreme events responsible for massive fossilization of the lingulides (see EMIG, 1986). In the upper layers of the outcrops, species diversity is strongly reduced while the number of fossilized individuals markedly increases, till *Lingula krausei* becomes the sole species preserved in the sandstone (NÖTLING, 1885). Such events took place in very shallow environments, called "*Strandfacies*" by NÖTLING (1885). A second brachiopod species *Rhynchonella depressa* (SOWERBY, 1825) has been reported but not in the same layers and is rather uncommon (NÖTLING, 1885).

Russian occurrences of *Lingula krausei* with associated fauna are reported in the vicinity of Saratov by LEONOV (1974) and KHARITONOV *et al.* (2003) and in Cenomanian terrigenous beds of the Tersa depression in the Kaluzhskaya region by SALTYSKOV & PERVUSHOV (2007) (Fig. 1).

Table 1: Width/Length, Height/L and H/W ratios "*Lingula*" *krausei*, compared to specimens of *Lingularia similis* and other species of the genera *Lingularia*, *Eolingularia*, *Sinolingularia*, *Sinoglottidia*, and to the extant genera *Lingula* and *Glottidia*. Data of *Sinolingularia* and *Sinoglottidia* from PENG & SHI (2008).

species	n	W/L		n	H/L		H/W		L
		range	mean		range	mean	range	mean	range
" <i>L.</i> " <i>krausei</i>	10	0.44-0.57	0.51	9	0.11-0.31	0.18	0.22-0.60	0.36	12.6-22.0
<i>L. similis</i>	66	0.44-0.75	0.62	12	0.19-0.23	0.23	0.36-0.44	0.39	7.9-29.2
<i>L. smirnovae</i>	17	0.47-0.55	0.51	1	0.12	0.12	0.23	0.23	11.4-23.3
<i>L. sp.</i>	43	0.62-0.75	0.67						5.7-15.4
<i>E. siberica</i>	9	0.45-0.56	0.50						4.3-8.5
<i>S. huananensis</i>	17	0.47-0.72	0.58						2.8-5.3
<i>S. yini</i>	20	0.45-0.72	0.63						2.4-4.6
<i>S. archiboldi</i>	17	0.53-0.75	0.66						1.4-4.3
<i>Lingula</i>	135	0.44-0.53	0.43-0.48	95	0.06-0.12	0.10	0.14-0.25	0.20	
except <i>L. adamsi</i>	31	0.54-0.70	0.63	19	0.11-0.18	0.13	0.16-0.26	0.20	
and <i>L. tumidula</i>	7	0.58-0.69	0.63						
<i>Glottidia</i>	35	0.32-0.44	0.33-0.40	35	0.09 – 0.11	0.09	0.15 – 0.25	0.20	

Table 2: Variations in the length of the lophophoral cavity and the anterior mantle canals in "*Lingula*" *krausei*, compared to the previously reported specimens belonging to the genus *Lingularia*, *Eolingularia*, *Sinolingularia*, *Sinoglottidia*, and to the extant *Glottidia* and *Lingula*. Length of the lophophoral cavity (expressed as a percentage) is the distance between the distal limit of the muscle scars (*i.e.*, anterior adductors on the ventral valve and anterior obliques on the dorsal valve) and the anterior margin of the valve relative to the whole valve length. Mantle canal tip (expressed as a percentage) is the distance between the tip of the canals and the anterior margin of the valve relative to the whole valve length. Data of *Sinolingularia* and *Sinoglottidia* from PENG & SHI (2008).

species	nV/nD	Lophophoral cavity (Lc)				Mantle canal tip (Mct)			
		Ventral %		Dorsal %		Ventral %		Dorsal %	
		range	mean	range	mean	range	mean	range	mean
<i>L. krausei</i>	3/3	43-46	45	29-38	34	27-39	32	36-41	39
<i>L. similis</i>	10/13	37-52	45	27-38	33	10-21	14	10-22	17
<i>L. smirnovae</i>	0/1							22	22
<i>E. siberica</i>	6/6	41-50	46	29-35	32	41-50	46	28-31	30
<i>S. huananensis</i>	2/8	36-52	39	36-52	45	17-26	22	17-26	20
<i>S. yini</i>	3/8	35-58	47	35-58	46	17-28	21	17-28	21
<i>S. archiboldi</i>	8/4	35-52	46	35-52	40	15-24	22	15-24	15
<i>Glottidia</i>	35/35	33-43	38	19-33	26	9-15	13	12-15	14
<i>Lingula</i>	44/44	35-46	41	24-35	31	17-22*	20	17-23*	20



Figure 2: "*Lingula*" *krausei*: a. ventral valve (external view); b. dorsal body side; c. ventral body side; d. dorsal valve (external view); e. ventral body side, showing nerve impressions; f. ventral body side. Scales are 0.5 cm. See also Fig. 3, and NÖTLING (1885): Fig. 12a-c (dorsal valve) and 12b (ventral valve). Blue arrow pointed on the small median septum on which the anterior oblique muscles are anchored; septum and muscles grow forwards during the shell development.

In this paper, on the basis of a new, excellently preserved material we re-describe and re-illustrate "*Lingula*" *krausei*, and establish its systematic position. Recently, several new species and new genera have been described or redescribed, in particular by SMIRNOVA & USHATINSKAYA (2001), PENG & SHI (2008), HOLMER & BENGTSON (2009), SMIRNOVA *et al.*, 2015), POSENATO (2016). Their results will be discussed herein, where the validity of several taxa is considered. Consequently, we propose a new genus *Eolingularia* with *Lingularia siberica* BERNAT et EMIG, 1993, as type species.

Material

The material studied comes from glacial erratics collected at Cape Rozewie, Poland (Fig. 1), and consists of several whole valves and tens of fragments of different sizes, all specimens occurring in glauconitic sandstone of Cenomanian age. The material is housed in the Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland, under the number ZPAL Bp.78.

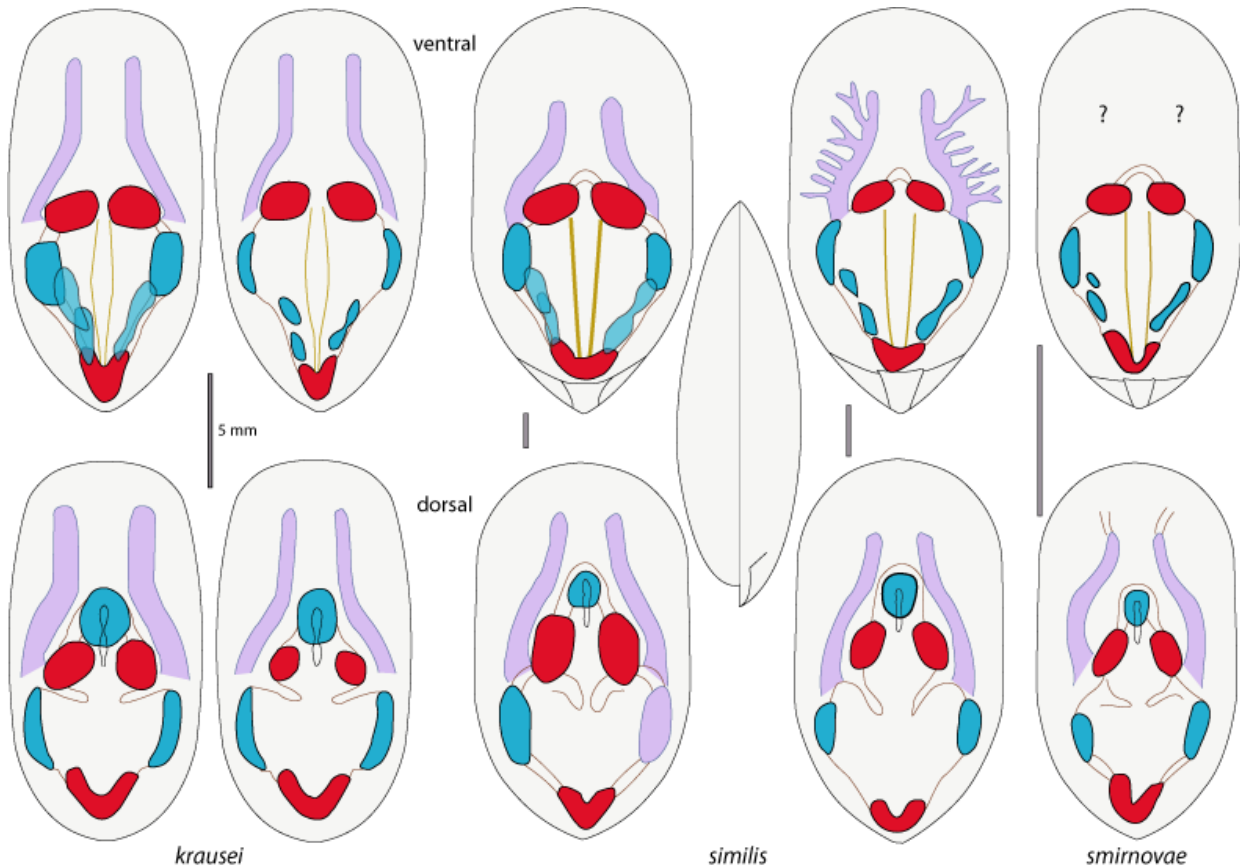


Figure 3 : Muscles disposition and variability, and main anterior mantle canals of "*Lingula*" *krausei*, *Lingularia similis* and *L. smirnovae*. For muscle arrangement, see Fig. 4.

Description of "*Lingula*" *krausei* DAMES

Umbonal region rounded with median beak, rostrated on ventral valve and weak on dorsal valve; large propareas separated by a broad pedicle groove. Body muscles characterized by median internal oblique narrowing near the middle. Mantle canals with S-shaped curves on both sides (Figs. 2-3).

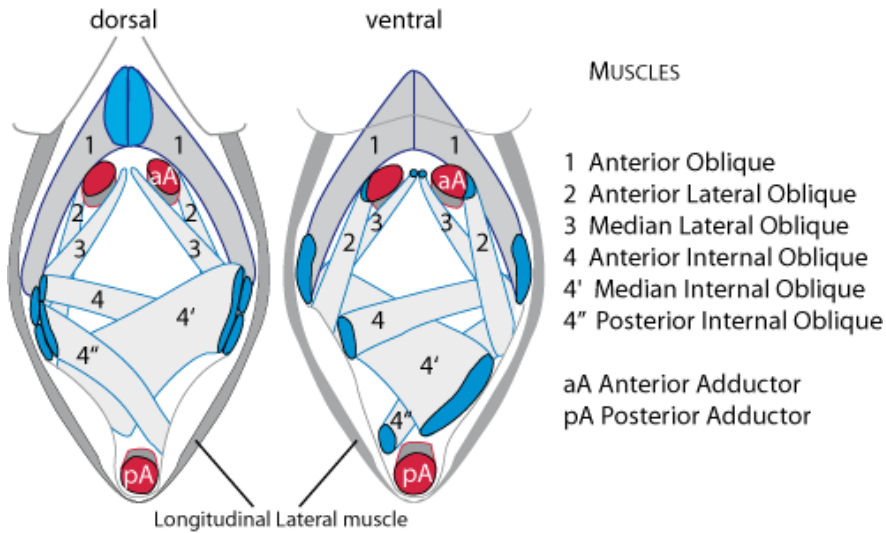
Shell. Elongate oval in outline, lateral margins subparallel; anterior margin generally rounded (Figs. 2-3); shell surface bears only subconcentric ribbing of variable prominence and spacing. Both valves moderately convex. Maximum width at mid-length of shell. Shell thickened in both valves between anterior adductors. External features, such as shape, size, and dimensional ratios of valves, have no taxonomic value (EMIG, 1982, 1983, 2002; BERNAT & EMIG, 1993). Consequently, they cannot be used to define either genus or species but may be provided as descriptive information additional to diagnosis.

Ventral valve and body area. Length: 12.6-22.0 mm, mean: 17.3 mm; width: 6.5-11.0 mm, mean: 8.5 mm; width/length ratio: 0.44-0.55, mean: 0.50 (n=7) (Tables 1-2; Figs. 2-3). A pair of narrow, subparallel grooves arises a short distance posterior to anterior adductors to merge, and terminates at level of posterior adductor. Umbonal region pointed to rostrated and continuous with posterolateral margins;

large propareas separated by broad pedicle groove. Mantle canals are strongly incurved, like dorsal canals. Perimial line, surrounding muscles (Figs. 3 & 7), is distinct. Internal median oblique muscle scar narrows near its middle. Scar of heart-like shaped posterior adductor commonly covers junction of pair of grooves (body nerves) (Fig. 3).

Dorsal valve and body area. Length: 16.2-21.8 mm, mean: 19.8 mm; width: 9.3-11.1 mm, mean: 10.4 mm; width/length ratio: 0.51-0.57, mean: 0.53 (n=3) (Tables 1-2; Figs. 2-3). A central narrow ridge extends 2-3 mm posteriorly from anterior oblique muscle scars. Umbonal region is rounded, with very weak median beak. Mantle canals are strongly incurved on both ventral and dorsal side. Perimial line is well-marked.

In specimens of *L. krausei* mean W/L ratio is 0.51 compared to 0.65 in specimens of *L. similis*, while the other ratios, H/L and H/W, are similar (Table 1; L= shell length, W=width, H=height). Regression curve is $W=1.07+0.45L$ $R^2=0.84$ for *krausei* and $W=-4.65+0.64L$ $R^2=0.81$ for *similis* (Fig. 5). Muscular disposition is similar in both species, as well as lophophoral cavity extension (Table 2). However, the extension of tips of mantle canals is similar to that of extant *Glottidia* (Table 2: three specimens measured), where tips reach closer to anterior margin than in Jurassic specimens.



◀ **Figure 4:** Muscle arrangement on dorsal and ventral faces (*Lingula anatina* is used as living example allowing body dissection). Note: internal face of a fossil valve acts as a mould because the body is located between two valves. In living specimens valves must be removed to see canal mantles and body muscles. No muscle scars can be seen on such valves. The position is as in life oriented anterior-posterior and left-right. Failure to observe these protocols may introduce confusion and misinterpretation.

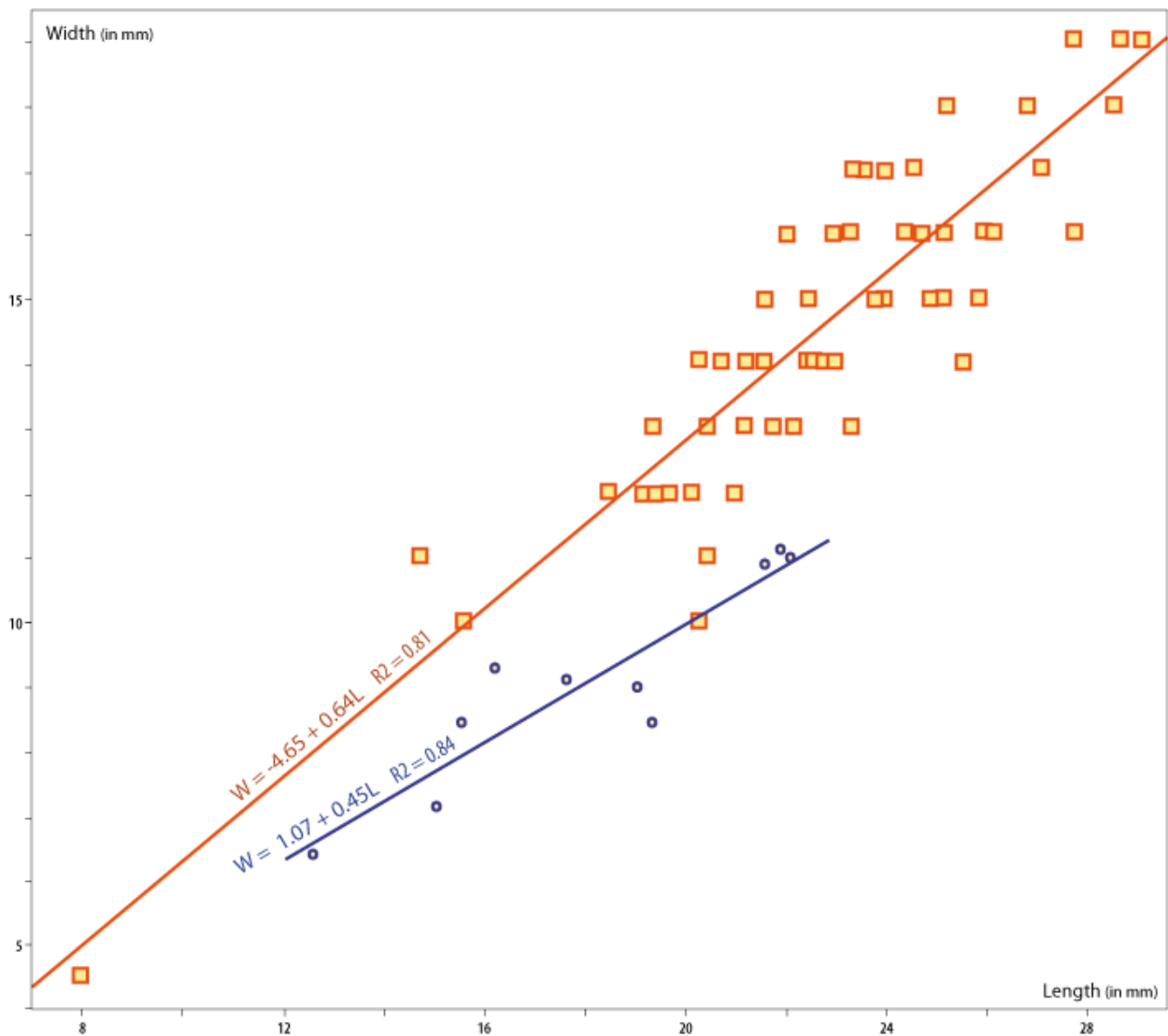


Figure 5: Frequency distribution of shell Width to Length ratios (W/L) and regression plots for "*Lingula*" *krausei*, in blue, and *Lingularia similis* in red. Data from Table 1. *L. krausei* has been recorded from Cenomanian of Cape Roze- wie (Poland) and *L. similis* from Middle Jurassic of Spitsbergen (BIERNAT & EMIG, 1993). Variation within a species of shell growth may be related to ecological conditions (EMIG, 1997).

Not all characters described herein, e.g., shell outline (see EMIG, 2002), can be considered as taxonomically significant, but as helpful ensuring more reliable identification. Variation in taxonomic characters cannot be used to describe a new species, nor the stratigraphic range to identify a fossil taxon. For example, PENG & SHI (2008) in commenting on EMIG's (2003) diagnosis of the Family Lingulidae stated that "the pseudointerarea is not always well developed as has been suggested by WILLIAMS (1977) and ARCHBOLD (1981)" (our emphasis). The term "well-developed" is vague and may be related to the size of an individual. Small specimens are immature ones and so have a small pseudo-interarea as noted by PENG & SHI (2008), HOLMER & BENGTON (2009), and WILLIAMS (1977), the latter observing that a pseudointerarea is absent in *Apsilingula parkesensis* WILLIAMS, 1977. All the specimens studied by these authors are millimetric in length (Table 1; Figs. 6-7). Such individuals have a broadly rounded anterior margin that becomes nearly straight to straight in mature specimens.

BIERNAT & EMIG (1993) reported that "photographs of internal moulds of *Lingula* *krausei* from the Cretaceous, sent by L. HOLMER, illustrate a great deal of similarity between this latter species and *Lingularia similis*, particularly in the disposition of mantle canals and of the ventral muscles." So it is surprising that HOLMER & BENGTON (2009), when describing the new species *Lingularia* ? *notialis* from Brazil did not compare it to *krausei*. We have done so and here assign it to *krausei*. HOLMER & BENGTON (2009) overlooked some muscular scars and the posterior adductor scar as complete. The additional material has led to a better grasp of the variation in the taxon's characters and, hence, a better description.

In the case of "*Lingula* *bagualensis* WILCKENS, 1905, from southern Patagonia which is morphologically similar to *Lingularia* ? *notialis* (Fig. 6), HOLMER & BENGTON (1996) initially referred to *Lingularia* but later conditionally placed it in *Credolingula* SMIRNOVA in SMIRNOVA & USHATINSKAYA, 2001. Nevertheless, HOLMER & BENGTON (2009) pointed out that this species is morphologically similar to species of *Lingularia*. Their data on taxonomic characters seem to be restricted to a few valves for *L. notialis* and a dorsal and ventral valve for *Credolingula bagualensis*. In the diagnosis provided by HOLMER and POPOV in volume 6, p. 2533, of the Treatise (SELDEN, 2007), *Credolingula* is characterized by "ventral valve interior with asymmetrical paired umbonal muscle". Consequently, this genus does not belong to the Family Lingulidae which has an unpaired posterior adductor muscle (EMIG, 2003). But PENG & SHI (2008) described a trapezoidal and horse-shoe-shaped posterior adductor scar. *Credo-*

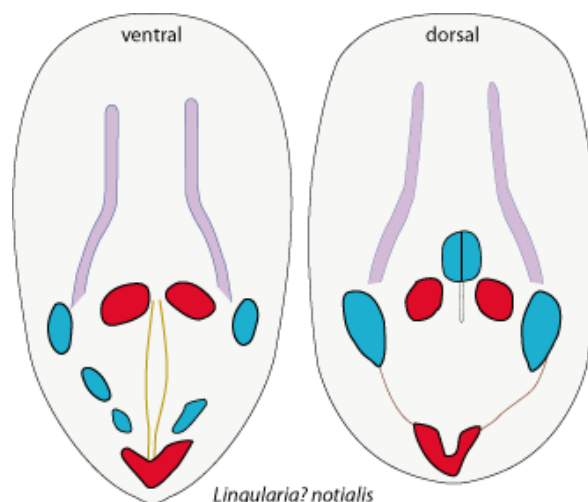


Figure 6: Muscle disposition established from original figures of HOLMER & BENGTON (2009), modified. Original length is respectively 6.2 and 5.8 mm.

lingula is incompletely described; before it is used, all taxonomic characters and a diagnosis must be soundly established, and all possible related species redescribed on the basis of well preserved internal sides of each valve (about ten of each is a minimum) (Fig. 7).

HOLMER & BENGTON (2009) alluded in several places to shell structure, especially in comparing *Lingula* and *Lingularia*, with reference to CUSACK *et al.* (1999). Mistaken observations made by CUSACK *et al.* (1999) include that several lingulides species belong to *Lingularia* and others to *Glottidia*, and that the genus *Glottidia* is known only from the Eocene and *Lingula* probably from the Oligocene. Consequently, their data need further investigation based on valid identification of the adult forms.

According to BALIŃSKI (1997), more paleontological data are needed to trace the process of gradual morphological modification of the embryonic lingulid shell.

POSENATO (2016) is the latest of several authors to observe that the study and application of internal taxonomic characters suggests a more complicated phylogenetic history than previously thought. This point has indeed been emphasized by EMIG since 1982. Discovery of new phylogenetic characters in living species is much more efficient than in fossil remains. The latter are very often described on the basis of incomplete characters as well as non-taxonomic ones or on stratigraphic data. It is important to bear in mind that when not all taxonomic characters are preserved the identification cannot be established or a new taxon described. Sometimes several tens or hundreds of specimens must be sampled to yield a sound identification.

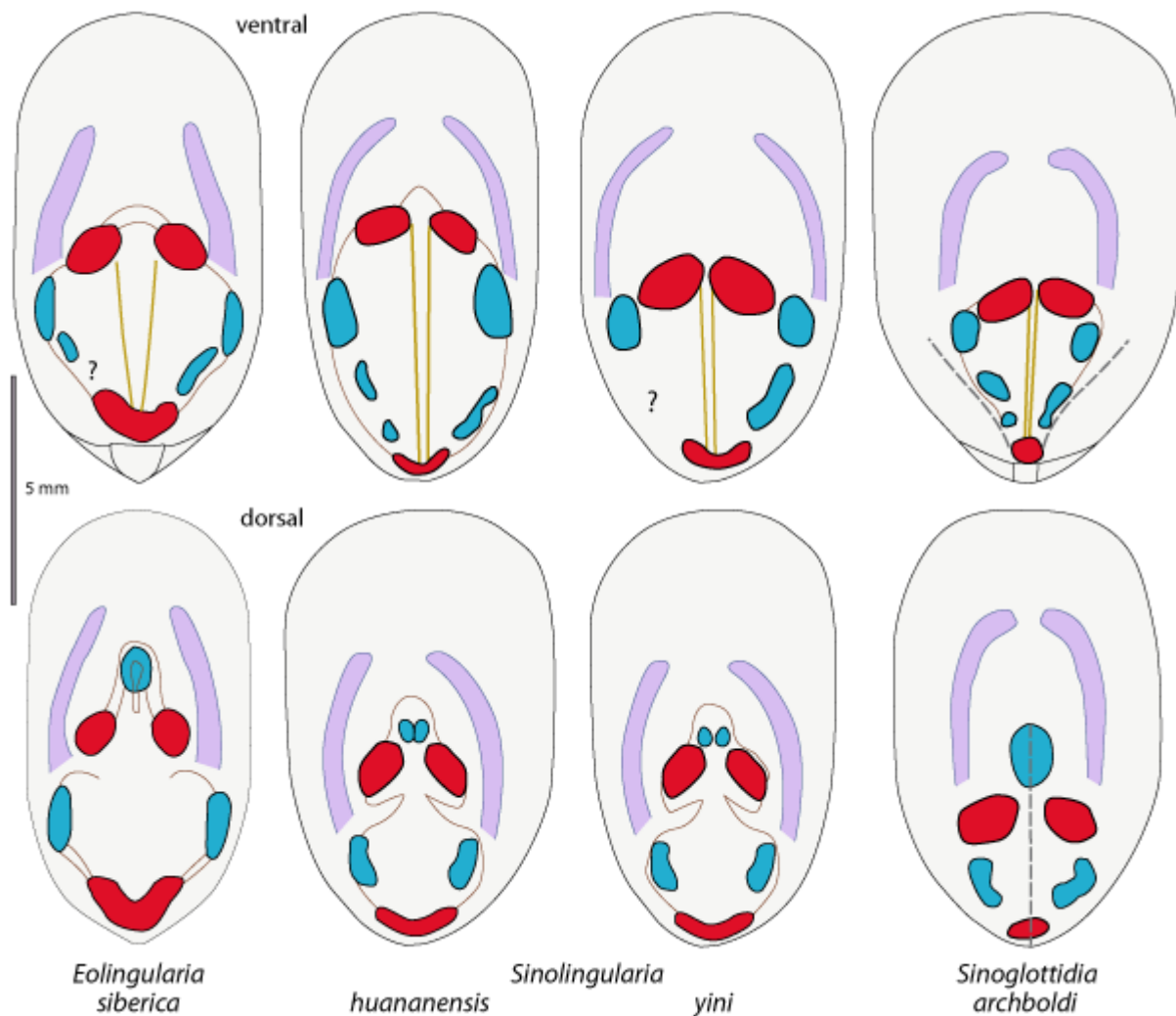


Figure 7: Disposition of muscles and anterior mantle canals in the type species of *Eolingularia* n. gen. compared to the species of *Sinolingularia* and *Sinoglottidia*, as figured by PENG & SHI (2008).

Systematics

Class Lingulata

GORJANSKY et POPOV, 1985

Order Lingulida WAAGEN, 1885

Family Lingulidae MENKE, 1828

Diagnosis (EMIG, 2003).- Shell elongate oval to subrectangular, gently and subequally bi-convex, subequivalved; lateral margins generally subparallel. Ventral valve with wide triangular pedicle groove and lateral vestigial propareas. Dorsal valve with posterior margin rounded, with a more or less developed median beak; anterior adductor and anterior oblique muscle scars closely spaced. Asymmetrical muscle system with internal oblique muscles; unpaired posterior adductor muscle; pedicle nerve curving around posterior adductor muscle. Mantle canal system bifurcate; *vascula lateralia* of both valves converging anteriorly to become subparallel; *vascula media* absent. Long flexible pedicle; lophophore spirolophous, with apices of spires directed medially.

DISCUSSION

POSENATO (2016) suggests emendation of the diagnosis of the Family Lingulidae by adding "asymmetrical paired umbonal or unpaired muscles". Thus one of the main characters of the family is eliminated without explanation nor any reference to the recent diagnosis proposed and discussed by EMIG (2003). An asymmetrical muscle system and a single umbonal muscle can be considered as apomorphies at least among the Linguloidea and a symmetrical muscle system and a pair of umbonal muscles as plesiomorphies, as shown in the other families of this superfamily. Consistent with EMIG's (2003) diagnosis, only five genera are included, *i.e.*, *Dignomia*, *Eolingularia*, *Lingularia*, *Lingula* and *Glottidia*. It should be noted that in cladistics a taxon can only have one state of a character. Consequently, the genus *Trentingula*, described by POSENATO (2016) with paired umbonal muscles, cannot be included in the Lingulidae. Nevertheless, it is likely that *T. lorigae* has an unpaired umbonal muscle (POSENATO, 2016, Pl. 1). However no information regarding the umbonal muscle is provided on the other new

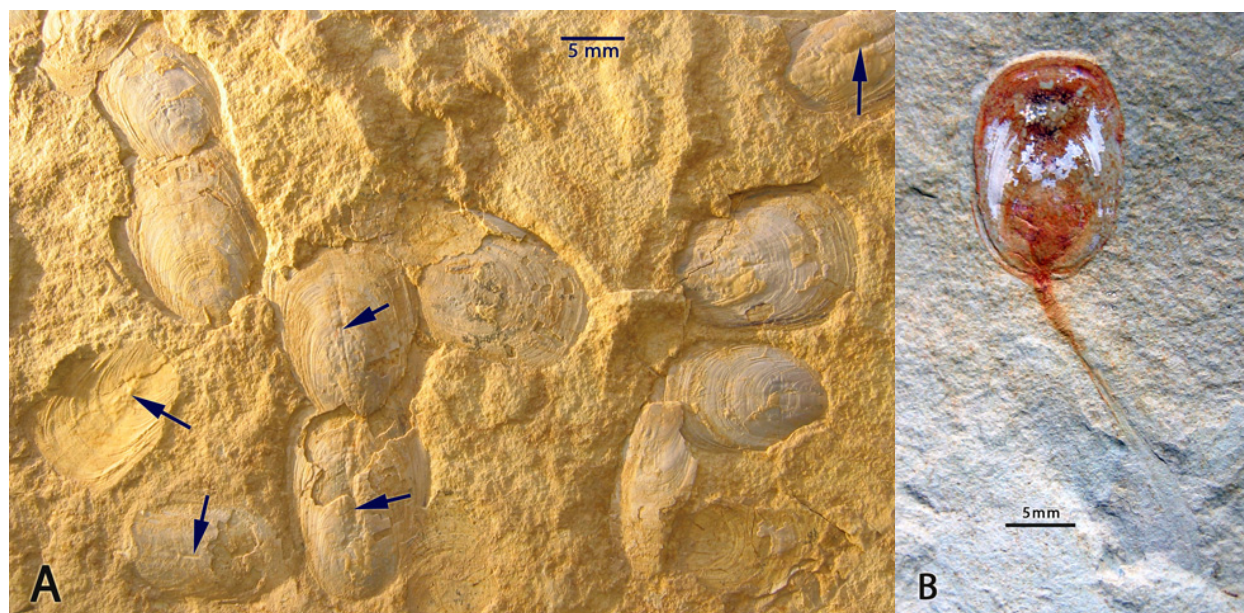


Figure 8: Triassic *Lingularia* sp. from Moya (SE Iberian Ranges, Spain): **A.** Showing valve deformation (arrows) related to taphonomic processes (see text). **B.** Entire specimen fossilized with pedicle and body parts (ventral side). Remnants of ventral valve are whitish (from MÁRQUEZ-ALIAGA *et al.*, 2007).

species, except for the case of unpaired muscles of Pl. 2, fig. 6 (POSENATO, 2016). For the most part the umbonal muscles are covered by the valve which has to be removed to identify the type of muscle, and cannot be identified as paired or unpaired.

The subfamilies proposed by several authors (see PENG & SHI, 2008) are not retained here because the diagnoses have characters, which apply exclusively to distinguish fossil taxa. Furthermore, the genera covered by these diagnoses are not identified and the generic diagnoses are modified according to the "new" proposed characters. In some cases taphonomic artefacts, including internal calcification, so-called muscle scars, and folds described as septa, have been used to create new fossil species.

Specimens from the Triassic of Moya (Province of Cuenca, SE Iberian Ranges, Spain; MÁRQUEZ-ALIAGA *et al.*, 2007) are similar to those previously described from Jalance (Province of Valencia, SE Iberian Ranges, Spain) and Henarejos (Province of Cuenca) by PRATS *et al.* (1987) and MÁRQUEZ-ALIAGA *et al.* (1999), respectively. Here they are assigned to *Lingularia*. Many valves are deformed, mainly along the longitudinal median line (Fig. 8). Such features should not be interpreted as primary, but as taphonomic. Probable rapid dehydration and heating induced the mass mortality of the lingulides and deformation of their valves. In Moya about two hundred specimens of *Lingularia* sp. (Fig. 8 ; Tables 1-2) have been carefully studied, but it has not been possible to identify the species. Thus, tens of specimens may sometimes be needed to validate a character and its variability.

Genus *Lingularia* BIERNAT et EMIG, 1993

Diagnosis.— Shell elongate-oval in outline, lateral margins subparallel, anterior margin broadly rounded. Valves weakly to strongly convex. Dorsal valve with posterior margin rounded, narrow median beak sometimes present, and a narrow internal central ridge extending over about 1 mm posterior to anterior oblique muscle scars. Ventral valve with triangular umbo formed by small to large internal propareas, continuous with posterolateral margins and separated by a deep pedicle groove; pair of narrow subparallel, V-shaped, grooves extends internally from the anterior adductor pair to posterior adductor where grooves join. Posterior adductor scar heart-like in outline. Main ventral canals shorter than dorsal canals, S-shaped on ventral and dorsal side.

TYPE SPECIES:

Lingularia similis BIERNAT et EMIG, 1993

Now regarded as a synonym of *Lingula krausei* DAMES, 1874—see ICZN (1999): article 67.1.

OTHER SPECIES:

Lingularia smirnovae BIERNAT et EMIG, 1993.

Lingularia michailovae SMIRNOVA, 2001 in SMIRNOVA & USHATINSKAYA (2001) – no diagnosis provided by SMIRNOVA.

Lingularia salymica SMIRNOVA, 2015 in SMIRNOVA *et al.* (2015) – no diagnosis provided by SMIRNOVA.

Genus *Eolingularia*
BITNER et EMIG, n. gen.

Diagnosis.— Shell elongate-oval in outline, lateral margins subparallel, anterior margin broadly rounded. Valves weakly to strongly convex. Dorsal valve with posterior margin rounded, narrow median beak sometimes present, and a narrow internal central ridge extending over about 1 mm posterior to anterior oblique muscle scars. Ventral valve with triangular umbo formed by small to large internal propareas, continuous with posterolateral margins and separated by a deep pedicle groove; pair of narrow subparallel, V-shaped, grooves extends internally from the anterior adductor pair to posterior adductor where grooves join. Posterior adductor scar heart-like in outline. Main ventral and dorsal canals curved and convergent anteriorly (Fig. 7).

Etymology of the name: from eo ("dawn" in Greek) and *lingularia*.

Eolingularia ranges from Carboniferous to Triassic in Russia, China, and Spain.

DISCUSSION

According to the original diagnosis of *Sinolingularia* by PENG & SHI (2008), only one character distinguishes this genus from *Lingularia*: "Both ventral and dorsal mantle canals (vascula lateralia) subparallel and convergent anteriorly" (PENG & SHI, 2008), which is a taxonomic character in *Eolingularia*. However, these authors stated that "the new genus closely resembles *Lingularia* BIERNAT et EMIG, 1993 but differs by its clearly separated dorsal antero-lateral muscle scars, V-shaped pedicle nerve grooves in the ventral valve that extend posteriorly without merging, and its rudimentary pseudo-interarea". In our opinion, none of these latter characters allows the genera to be distinguished because of their variability (see BIERNAT & EMIG, 1993; EMIG, 2002, 2003).

Similarly, from the original diagnosis of *Sinoglottidia* PENG et SHI, 2008, it seems clear that a single character distinguishes this genus from *Lingularia* is: "Dorsal valve with a median septum extending from posterior adductor scar to antero-lateral muscle scars; ... Both ventral and dorsal mantle canals (vascula lateralia) subparallel and convergent anteriorly". It should be noted that the so-called median septum could be a post-mortem folding due to taphonomic processes (see Fig. 8). No view of this septum from the internal side of dorsal valves is shown. Mantle canals are similar as in *Eolingularia*.

Another argument against the erection of this genus is the small size of the specimens which were probably immature with incompletely developed characters. The difficulty in identifying small (<10 mm) immature individuals

has been emphasized repeatedly in living forms by EMIG (1982). Moreover, EMIG (2002) pointed out that, as in extant lingulides, the importance of a small median ridge or septum generally increases with the growth of the shell. The anterior oblique muscles are anchored on.

TYPE SPECIES:

Lingularia siberica
BIERNAT et EMIG, 1993

Diagnosis.— Numerous fine radial striae and commonly concentric microlines between thicker growth lines generally visible on the shell. Umbonal region rounded on dorsal valve, pointed on ventral valve; small propareas separated by a deep striated pedicle groove, not continuous with the internal valve face. Body muscles characterized by internal anterior oblique located near anterior oblique; internal posterior oblique not observed. Mantle canals almost curved, convergent, on both sides (Fig. 7).

DISCUSSION

Finally, we consider that the status of the *Sinolingularia huananensis* PENG et SHI, 2008, and *Sinoglottidia archboldi* PENG et SHI, 2008, remains contentious until their taxonomic characters have been clearly defined and their variability established. For example, PENG & SHI (2008) distinguish *huananensis* from *yini* as follows: "Antero-lateral muscle scars in dorsal valve lacrymiform, separated anteriorly and connected posteriorly, and antero-lateral muscle scars in dorsal valve lacrymiform, separated anteriorly and connected posteriorly"; but, in both species the antero-lateral muscle is "closely located near central muscle scars". Anatomically, on the dorsal side the antero-lateral muscle is named in this paper, the anterior oblique muscle following EMIG's nomenclature (1982) (Fig. 4); the oblique muscles act in scissor-like movements of the valves, an action that requires strong anchorage on the valves (EMIG, 1997). Dorsally the anterior oblique muscles are anchored on a small and short median ridge which is lacking or not readily visible in immature individuals – it may be present in Fig. 6A of PENG & SHI (2008). The central muscle is the anterior adductor – which, with the posterior adductor acts to close the shell. Further, the positions of the muscles are dependent on the age of the individual, as they shift with the growth of the shell throughout life. Consequently muscle scars show greater or lesser variability in their disposition and shape (Fig. 7).

Complementary data

Additional comments on several lingulide species cited here follow.

***Lingula subspatulata*
HALL et MEEK, 1855**

HALL & MEEK (1855) remarked about their new species: "The only specimen we have is imperfect, and the shell is preserved only on the margins. It has nearly the proportions of *Lingula Rouliniana*, (d'ORBIGNY, Pal. Française, Terrains Crétacés, Brach. p. 10, p. 490, Fig. 1,) but differs in having its greatest width above the middle, while in the European species the greatest width is below the middle. Our species is also more abruptly rounded or sub-truncate at the base. The surface markings are similar." The persistence of this scientific folly may be related to the conservatism of the palaeontological community. A partial explanation is contained in the answer of an American specialist on Mesozoic brachiopods, who in 2003 wrote to one of us (CCE) by email: "[There are people] people who study faunal lists and databases instead of anatomy and taxonomy, and thus perpetuate older nomenclature. As the ecology and distribution of lingulides does not seem to have changed dramatically since their origin, the name "*Lingula*" has a tremendous amount of inertia" (EMIG, 2008).

About this species recorded in the Cenomanian of Texas, STEPHENSON (1952) pointed out: "In the absence of the soft parts, and the views of the interior, the simplicity and similarity of the shells of many of the members of the group are such as to render difficult their separation into clearly defined species", and further: "Many specimens have suffered more or less mechanical compression". SCOTT (1970) pointed out that, for specimens ranging from Cenomanian to Maastrichtian, "the absence of radial sculpture might provide a basis for placing these specimens in a new species". Confusion is induced by description of new species on the basis of characters that are neither taxonomically nor phylogenetically valid. Furthermore, a fossil is far from being equivalent to a living individual. On the contrary, living individuals are not described in the same way as fossil ones which are identified solely on shell characters.

***Lingula mytiloides* SOWERBY, 1813**

JACK & ETHERIDGE (1892) recorded this species from the Permo-Carboniferous, of Queensland, Australia.

***Lingula ovalis* SOWERBY, 1855 and
L. subovalis DAVISON, 1852**

MOORE (1870) identified the Cretaceous species, *L. subovalis* in the same assemblage as the English Jurassic *Lingula ovalis* SOWERBY, and even though he seems to have regarded *L. subovalis* as a synonym (*op. cit.*, p. 236), the occurrence of *L. ovalis* is used as evidence for the Jurassic age of the fauna (*op. cit.*, p. 239) – see also TATE (1889).

From the Lower Cretaceous of Queensland, Australia, JACK & ETHERIDGE (1892) stated that the "names probably refer to the same species", following MOORE's opinion. DAY (1967) referred his Cretaceous lingulide specimens to *Lingula* cf. *subovalis* DAVIDSON, and regarded *L. ovalis* SOWERBY as a synonym.

MORTON (1982) described *Lingula sturti*, synonymizing the Australian specimens referred earlier to *L. ovalis* and *L. subovalis*. Unfortunately, his description is incomplete and does not allow the identification the specimens as belonging to a new species.

Miscellaneous Lingulids

Several authors listed Mesozoic *Lingula*, including ROLLIER (1916), TERQUEM (1850) and DAVIDSON (1876). In each case, the description is insufficient to allow identification to species level.

The species described as "*Glottidia*" *rostrata* by THOMSON and OWEN (1979) from the Lower Cretaceous of Alexander Island (Antarctica) does not show the characters of *Glottidia* (see EMIG & BITNER, 2005).

Two species have been recorded by THOMSON (1971) in the Lower Cretaceous of Alexander Island, Antarctic Peninsula, *L. beanii* PHILIPS and *L. cf. subovalis* DAVIDSON. Both species seem to be cosmopolitan. Such an occurrence can be determined only on the basis of very well defined taxonomic characters which allow confident differentiation of the two forms. This is not the case, so that only one species is likely to be present.

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